Sissejuhatus infotehnoloogiasse

Loengu ülevaade

Kordamine: 20 sajandi alguseks oli olemas ...
Teooria: kümnend enne II maailmasõda

Turing, Church, Wittgenstein, Shannon

Universaalarvutite teke: ca II maailmasõda

Esimesed võimsad arvutid teises maailmasõjas
Zuse, Neumann ja Hopper; esimesed programmeerimiskeeled

Peale II maailmasõda kuni kuuekümnendad

Transistorid, integraalskeemid, mälu
Esimene kõrgkeel: Fortran
Integraalskeemid ja protsessorifirmade teke
Suur-, mini- ja mikroarvutid

20 sajandi alguseks oli olemas:

Mingi hulk baasteooriat:

- Lausearvutus
- Predikaatarvutuse varane versioon (Frege)

Tulevaste arvutite jaoks nö “võimaldavat tehnoloogiat”:

- Peenmehaanika
- Elekter ja releed
- Kirjutusmasinad
- Telegraaf
- Perfolindid ja -kaardid
- Mehaanilised mitteprogrammeeritavad kalkulaatorid
- Esialgsed ideed programmeeritavate mehaaniliste masinate jaoks

Hollerith’i perfokaardid

1890: Herman Hollerith: perfokaartidega masin USA rahvaloenduse andmete töötlemiseks

Hollerith’i firmast tekkis **IBM**

Hulgateooria: Georg Cantor

Elas 1845-1918
Hulgateooria rajaja
Paradokside avastamine matemaatikas
Matemaatika alused korraga ebakindlad

Vaakumtorud

1900: vaakumdiood

Lee de Forest: 1906: vaakumtriood

Russell & Whitehead

1910-1913: massiivne loogikatraktaat
  Principia Mathematica
Paradoksid -> tüüpide teeoria
Filosoofilised vaated: logitsism

Formalism; Hilbert

Loogik ja matemaatik: 1862-1943

Filosoofilistelt vaadetelt **formalist**

“**Hilberti programm**” matemaatikale kindlate aluste rajamiseks:

Matemaatika alused tuleb esitada loogika keeles, range aksiomaatikana.

Tuleb tõestada, et nimetatud aksiomaatika ei ole vastuoluline, st temast ei ole võimalik tuletada korraga mingit väidet A ja sellesama väite eitust -A

Formaalne süsteem

Tarski ja Carnap

Süntaks

Tuletamisreeglite süsteem

Semantika

Ludwig Wittgenstein

1889-1951

Analüütilise filosoofia juhtkuju

Innustas loogilise positivismi ja Viini ringi teket:

- Mõtestatud tekst koosneb kas (a) loogika ja matemaatika formaalsetest väidetest või (b) konkreetsete teadusharude fakte esitavatest lausetest.
- Igasugusel fakti esitaval väitel on sisu ainult siis, kui on võimalik öelda, kuidas selle väite kehtivust kontrollida.
- Metafüüsilised väited, mis ei lange punktide 1 ja 2 alla, on sisutud.
- Kõik moraali, esteetikat ja religiooni käsitlevad väited on mittekontrollitavad ja mõttetud.

Turingi masin & Churchi lambda-arvutus

1935-1937: artikkel **Turingi masinast:** universaalsus, mittelahenduvus

1936: Churchi **lambda-arvutus**, **Churchi tees**.

universaalsus, mittelahenduvus

Täielikkus ja mittetäielikkus

Kurt Gödel (1906-1978)

1930: loogika baaskeel predikaatarvutus on täielik

1931: formaalne aritmeetika ei ole täielik, seda ei saagi lõpliku formaalse süsteemiga kirjeldada

Tõestuse idee:

Tõestuse alusidee on tuntud valetaja paradoks: kas väide ``ma praegu valetan'' on tõene või mitte? Lihtne arutlus näitab, et ta ei saa olla kumbagi.

Koostame nüüd sellise aritmeetilise väite A, mis ütleb, et seesama A ei ole tõestatav (see väide ei ütle, et A ei ole tõsi!). Siis ei saa väide A ise olla vale. Tõepoolest, kui A oleks vale, siis A sisu kohaselt peaks A olema tõestatav. Kuna me valesid väiteid tõestada ei saa, siib peabki A olema õige. Kuna A on õige, peab kehtima see, mida A väidab: A pole tõestatav. Tõepoolest, kui A oleks tõestatav, siis oleks A sisu ("A ei ole tõestatav") vale, see on aga, nagu näidatud, võimatu. Kokkuvõtteks, A on õige, aga ei A ega A eitus pole tõestatavad.

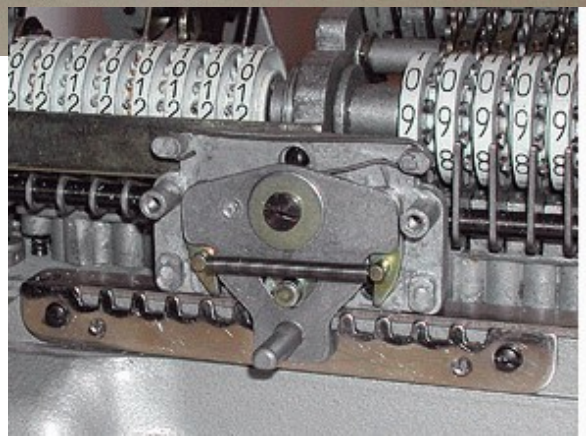
Claude Shannon

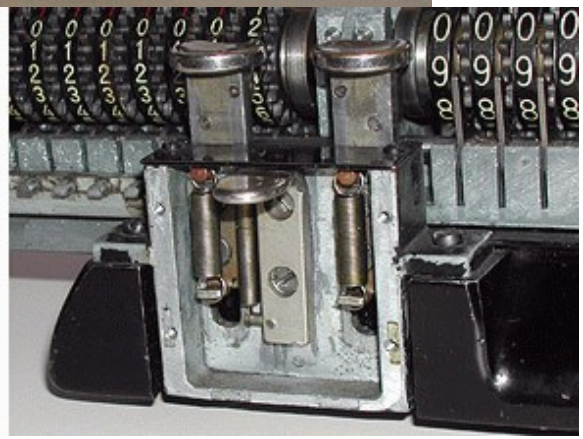
MIT, 1938, Shannon’i magistritöö sidus:

- Boole algebra
- Elektrilülitid ja -skeemid
- Bitid ja info kodeerimise
- Info otsimise algoritmid

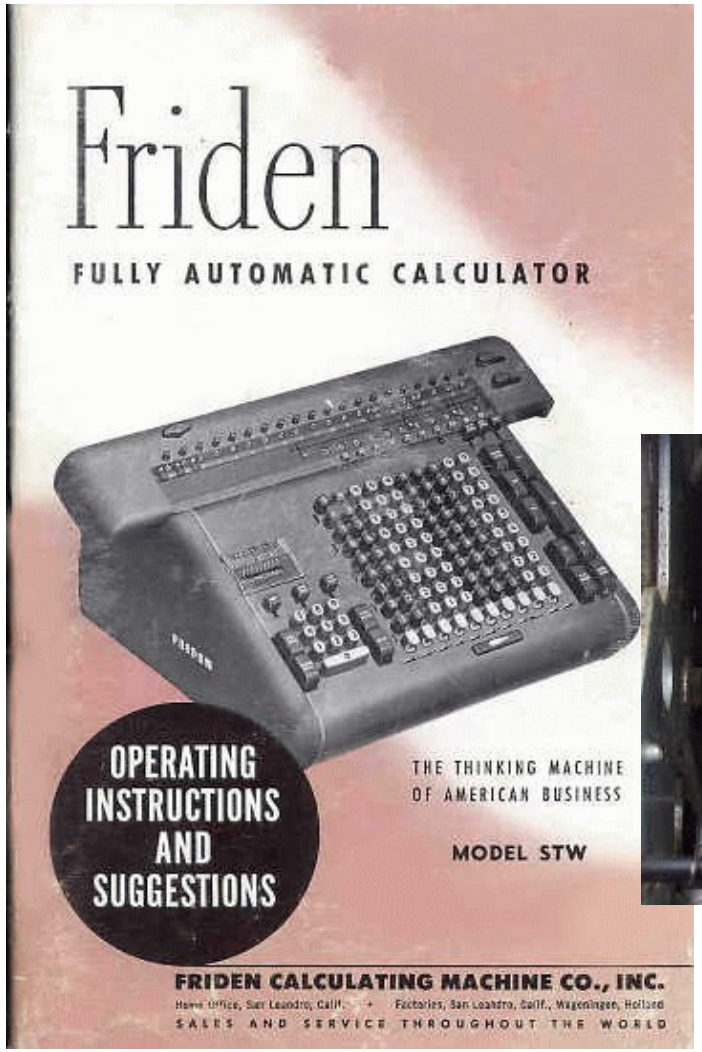
Mehhaanilised kalkulaatorid

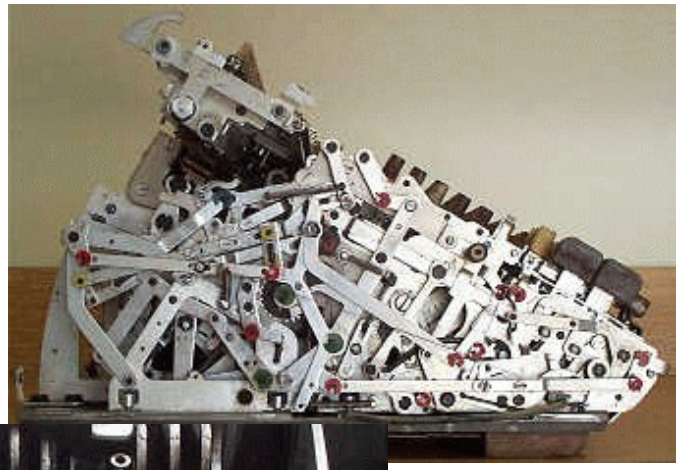
Felix vs “original Odhner”:

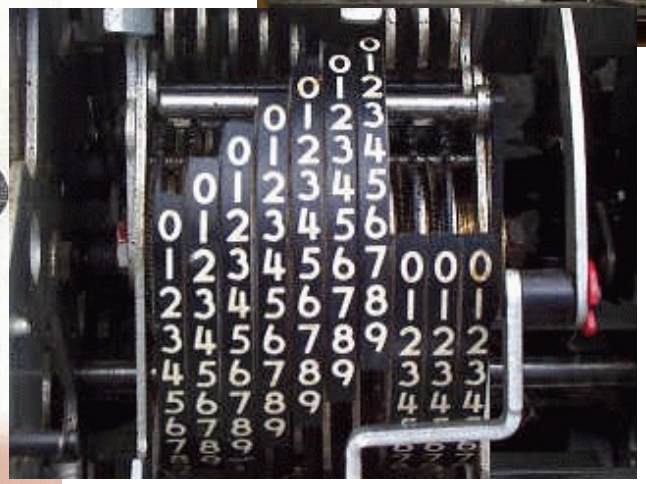




Mehhaanilised kalkulaatorid







Esimesed suured digitaalarvutid

Defining characteristics of five first operative digital computers

Computer	Nation	Year	Digital	Bin	Electr	Program	Turing complete
Atanasoff-Berry	USA	1937−42	Yes	Yes	Yes	No	No
Zuse Z3	Germany	1941	Yes	Yes	No	Fully, by paper tape	Yes
Colossus	UK	1944	Yes	Yes	Yes	Partially, by rewiring	No
Harvard Mark I/IBM	USA	1944	Yes	No	No	By paper tape	Yes
ENIAC	USA	1946	Yes	No	Yes	Partially, by rewiring	Yes

Vannevar Bush

MIT: 1930-1935-1937: Differential Analyzer dif. võrrandite lahendamiseks

Viimane versioon:

- kaalus 100 tonni
- 2000 elektronlampi
- 150 mootorit
- tuhanded releed

Atanasoff'i arvuti

John Vincent Atanasoff

1939-1942: esimene elektronarvuti?

Zuse arvuti

Konrad Zuse

1941-1944: Z3, Z4

Releedega digitaalarvuti

Colossus vs Geheimfernschreiber

Londonis 1943: saksa allveelaevade salakirja dekodeerimiseks

1800 elektronlampi

Ideoloogia ja matemaatika töötas välja Alan Turing, kes varem juhtis lihtsama ENIGMA dekodeerimist

Mark I

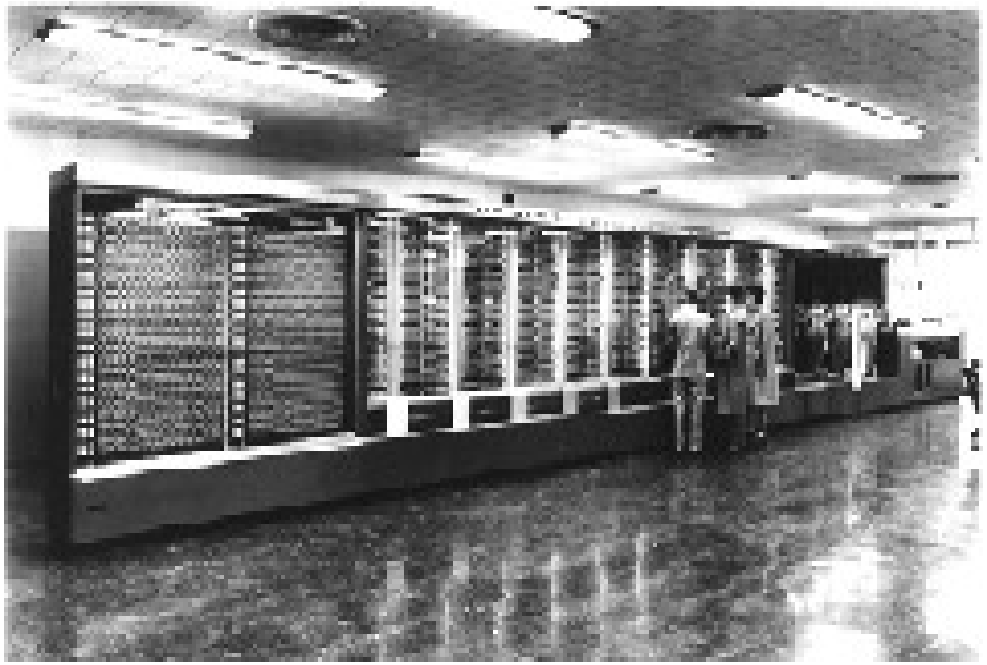
Howard Aiken

IBM’i elektriline (releed) digitaalne arvuti MARK I

1939-1944

750.000 komponenti

5 tonni



1945

Konrad Zuse began work on **Plankalkul** (plan Calculus). The first algorithmic programming language, with an aim of creating the theoretical preconditions for the formulation of problems of a general nature.

John von Neumann wrote "First Draft of a Report on the EDVAC."

Grace Hopper recorded the first actual computer actual "bug."

1946

In February, the public got its first glimpse of the **ENIAC**, a machine built by John Mauchly and J. Presper Eckert that improved by 1,000 times on the speed of its contemporaries.

START OF PROJECT: 1943

COMPLETED: 1946

PROGRAMMED: plug board and switches

SPEED: 5,000 operations per second

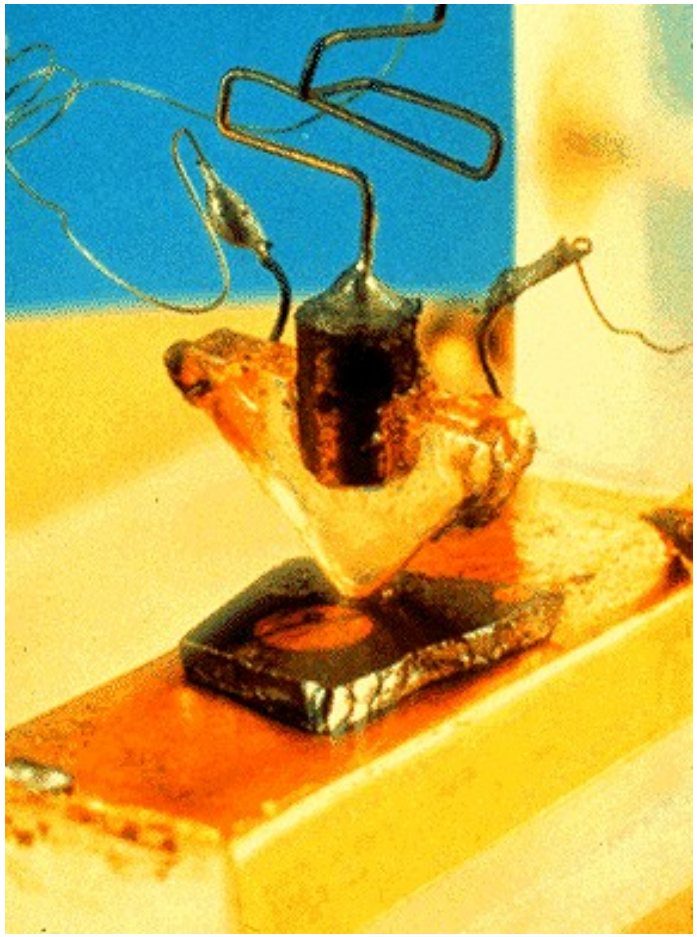
INPUT/OUTPUT: cards, lights, switches, plugs

FLOOR SPACE: 1,000 square feet

PROJECT LEADERS: John Mauchly and J. Presper Eckert.

1947

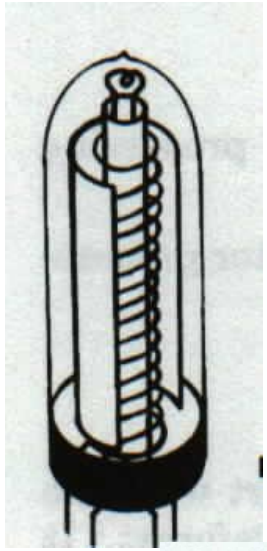
Three scientists at **Bell Telephone Laboratories**, William Shockley, Walter Brattain, and John Bardeen demonstrate their new invention of the point-contact transistor amplifier.



Kordamine: raadiolambi tööpõhimõte

Vacuum Tube (1906, Lee Deforest)

Three elements device used as electronic switch and amplifier: two electrodes separated by a grid in a vacuum glass enclosure.

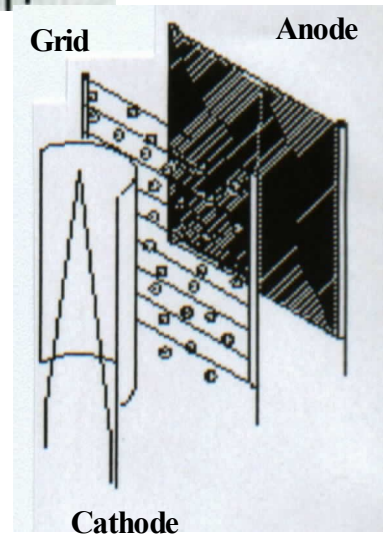


Principle

Cathode - emits electrons;

Plate (anode) - receives the electrons;

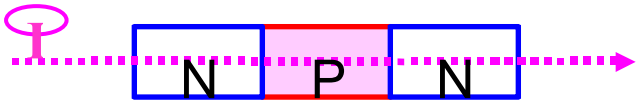
Grid - with negative bias voltage repels some of the electrons and prevents them from reaching the plate, resulting in less current flow. A changing negative charge on the grid modulates the plate current.



Transistori tööpõhimõte

Transistor

Three elements solid-state device for amplifying, controlling electrical signals.

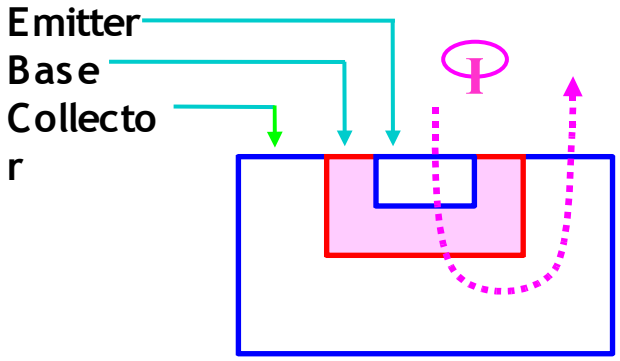


Principle

Current flows from emitter through base into collector;

Switching - Base current on, collector current flows - Switching;

Amplification - Base current regulates large amount of collector current.



1948

John Bardeen, Walter Brattain, and William Schockley of Bell Labs file for **a patent on the first transistor**.

The Mathematical Theory of Communication. Claude **Shannon**'s "The Mathematical Theory of Communication" showed engineers how to code data so they could check for accuracy after transmission between computers. Shannon identified the bit as the fundamental unit of data and, coincidentally, the basic unit of computation.

Norbert Wiener published "**Cybernetics**," a major influence on later research into artificial intelligence. He drew on his World War II experiments with anti-aircraft systems that anticipated the course of enemy planes by interpreting radar images.

1949

Maurice Wilkes assembled the **EDSAC**, the first practical **stored-program computer**, at Cambridge University. His ideas grew out of the Moore School lectures he had attended three years earlier. For programming the EDSAC, Wilkes established a library of short programs called subroutines stored on punched paper tapes.

TECHNOLOGY: vacuum tubes

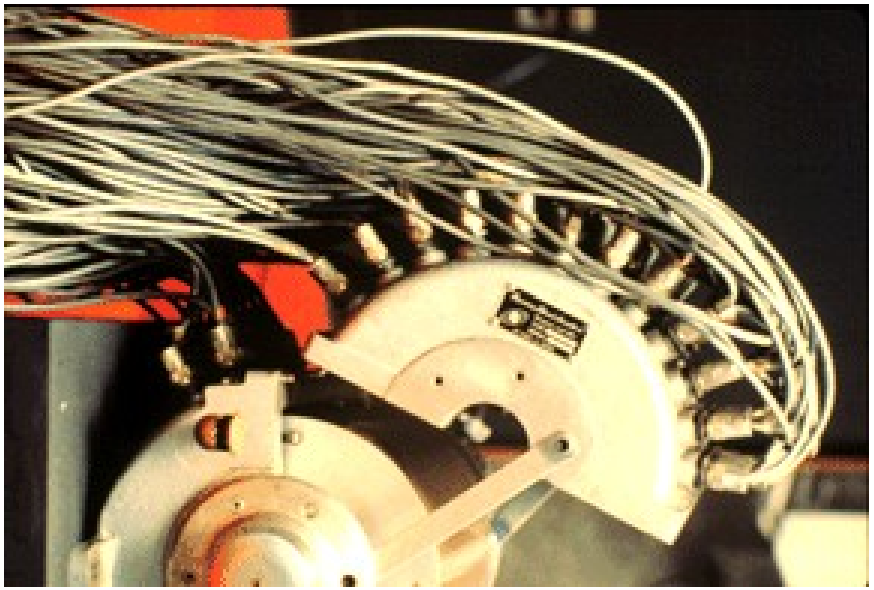
MEMORY: 1K words, 17 bits, mercury delay line

SPEED: 714 operations per second

1950

- Engineering Research Associates of Minneapolis built the **ERA 1101, the first commercially produced computer**; the company's first customer was the U.S. Navy.

  It held 1 million bits on its **magnetic drum**, the earliest magnetic storage devices. Drums registered information as magnetic pulses in tracks around a metal cylinder. Read/write heads both recorded and recovered the data. Drums eventually stored as many as 4,000 words and retrieved any one of them in as little as five-thousandths of a second.



1951

- The **UNIVAC I** delivered to the U.S. Census Bureau was the first **commercial computer to attract widespread public attention**. Although manufactured by Remington Rand, the machine often was mistakenly referred to as the "IBM UNIVAC." Remington Rand eventually sold 46 machines at more than $1 million each.

SPEED: 1,905 operations per second

INPUT/OUTPUT: magnetic tape, unityper, printer

MEMORY SIZE: 1,000 12-digit words in delay lines

MEMORY TYPE: delay lines, magnetic tape

TECHNOLOGY: serial vacuum tubes, delay lines, magnetic tape

FLOOR SPACE: 943 cubic feet

COST: F.O.B. factory $750,000 plus

Early AI programs: checkers, chess (in Britain)

Strachey wrote a **checkers program** for the Ferranti Mark I at Manchester (with Turing's encouragement and utilising the latter's recently completed Programmers' Handbook for the Ferranti computer). By the summer of 1952 this program could, Strachey reported, "play a complete game of Draughts at a reasonable speed".

Prinz's **chess program**, also written for the Ferranti Mark I, first ran in November 1951. It was for solving simple problems of the mate-in-two variety. The program would examine every possible move until a solution was found. On average several thousand moves had to be examined in the course of solving a problem, and the program was considerably slower than a human player.

Turing started to program his **Turochamp chess-player** on the Ferranti Mark I but never completed the task. Unlike Prinz's program, the Turochamp could play a complete game and operated not by exhaustive search but under the guidance of rule-of-thumb principles devised by Turing.

Early AI programs: checkers (in USA)

The first AI program to run in the U.S. was also a checkers program, written in 1952 by **Arthur Samuel** of IBM for the IBM 701.

Samuel took over the essentials of Strachey's program (which Strachey had publicised at a computing conference in Canada in 1952) and over a period of years considerably extended it.

In 1955 he added features that enabled the program to learn from experience, and therefore improve its play. Samuel included mechanisms for both rote learning and generalisation. The program soon learned enough to outplay its creator. Successive enhancements that Samuel made to the learning apparatus eventually led to the program winning a game against a former Connecticut checkers champion in 1962 (who immediately turned the tables and beat the program in six games straight).

1952

Heinz Nixdorf founded **Nixdorf Computer Corp**. in Germany. It remained an independent corporation until merging with Siemens in 1990.

A complaint is filed against IBM, alleging **monopolistic practices** in its computer business, in violation of the Sherman Act.

G. W. Dummer, a radar expert from Britain's Royal Radar Establishment presents a paper proposing that **a solid block of materials be used to connect electronic components**, with no connecting wires.

1953

IBM shipped its first **electronic computer**, the 701.

Speedcoding: John Backus.

1954

Texas Instruments announces the start of **commercial production on silicon transistors**. [110]

Herbert Simon and Allen Newell unveiled **Logic Theorist software** that supplied rules of reasoning and proved symbolic logic theorems.

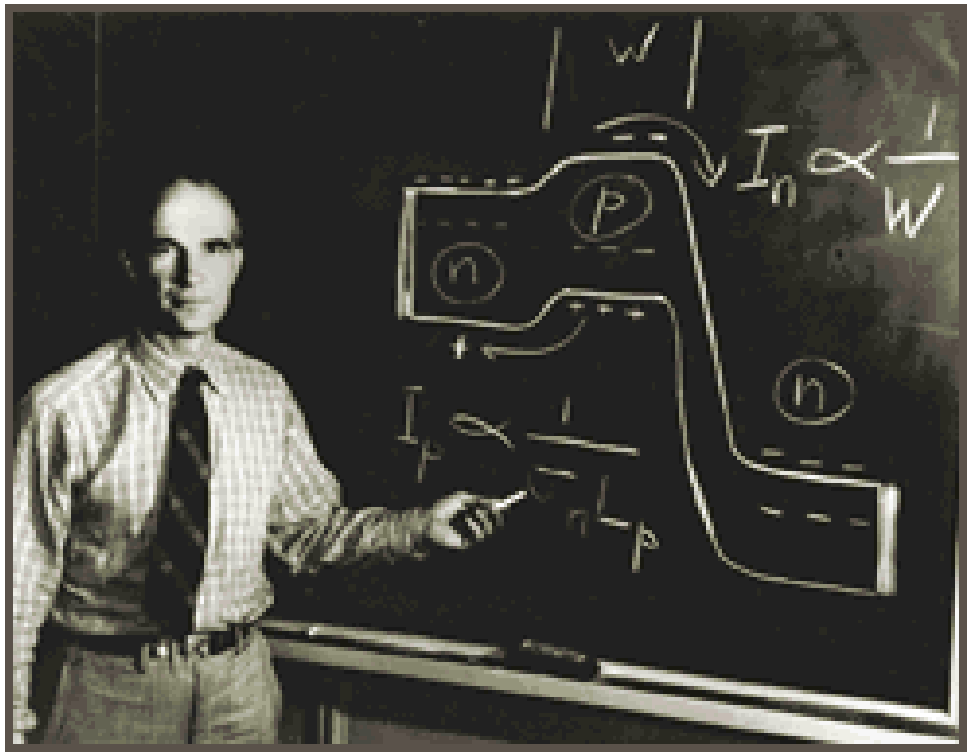
The Logic Theorist, as the program became known, was the major exhibit at a conference organised in 1956 at Dartmouth College, New Hampshire, by John McCarthy, who subsequently became one of the most influential figures in AI.

Newell, Simon and Shaw went on to construct the General Problem Solver, or GPS. The first version of GPS ran in 1957 and work continued on the project for about a decade. GPS could solve an impressive variety of puzzles, for example the "missionaries and cannibals" problem.

1955

William Shockley founds **Shockley Semiconductor** in Palo Alto, California

However, the venture did not go well, partly because of Shockley's managerial style, and partly because he diverted resources away from transistor technology and into the creation of a 4-layer switching diode, a device which he had conceived whilst still at Bell.



1956

A U.S. District Court makes a **final judgement on the complaint against IBM** filed in January 1952 regarding monopolistic practices. A "consent decree" is signed by IBM, placing limitations on how IBM conducts business with respect to "electronic data processing machines".

IBM develops **the first hard disk**, the RAMAC 305, with 50 two-foot diameter platters. Total capacity is **5 MB**. (350 Disk Storage Unit)

The first transistorized computer is completed, the TX-O (Transistorized Experimental computer), at the Massachusetts Institute of Technology.

The Nobel Prize in physics is awarded to John Bardeen, Walter Brattain, and William Shockley for their **work on the transistor**.

1957…

A new language, **FORTRAN** (short for formula translator), enabled a computer to perform a repetitive task from a single set of instructions by using loops.

The first commercial FORTRAN program ran at Westinghouse, producing a missing comma diagnostic.

A successful attempt followed.

Programmer's
Reference Manual
October 15, 1956

THE FORTRAN
AUTOMATIC CODING SYSTEM
FOR THE
IBM 704 EDPM

This manual supersedes all earlier information about the FORTRAN system. It describes the system which will be made available during late 1956, and is intended to permit planning and FORTRAN coding in advance of that time. An Introductory Programmer's Manual and an Operator's Manual will also be issued.

… 1957

A group of eight engineers leaves Shockley Semiconductor to form **Fairchild Semiconductors**

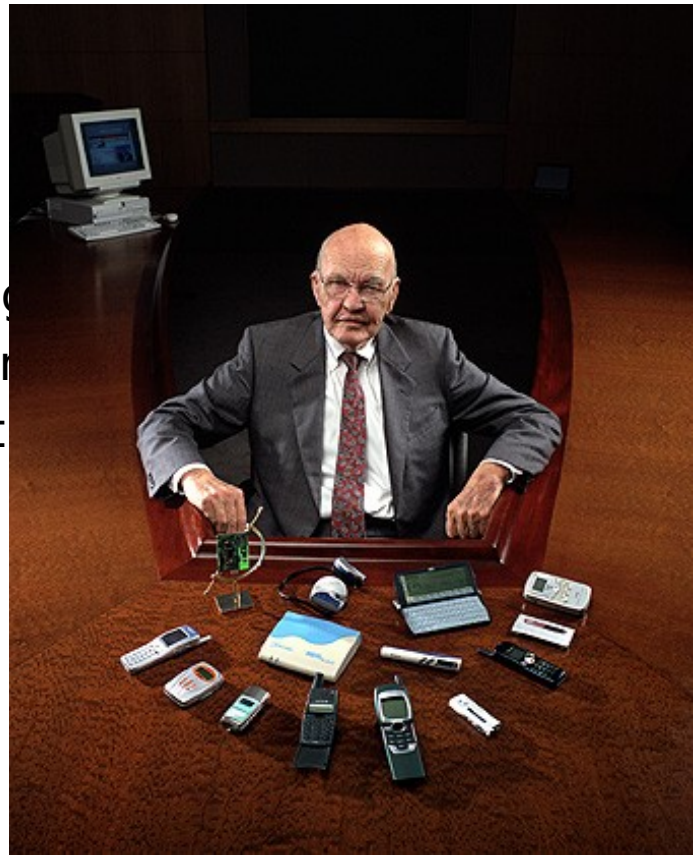
Kenneth Olsen founds **Digital Equipment Corporation**.

Left to right: Moore, Roberts, Kliner, Noyce, Ginrich, Blank, Hoerni, Last

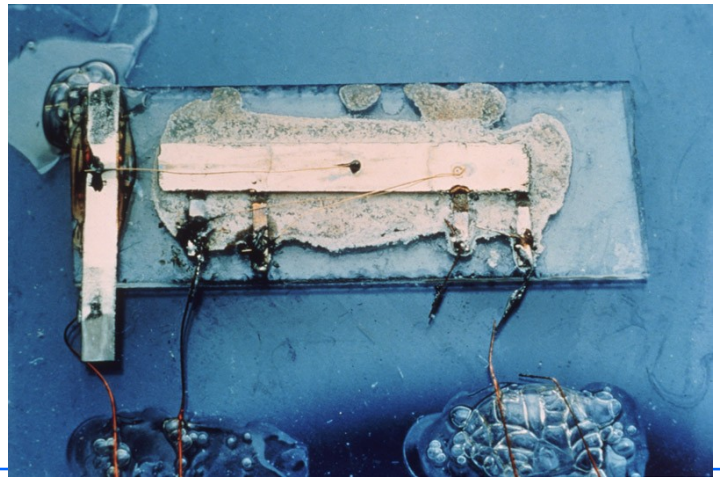
1958

At **Texas Instruments**, **Jack St. Clair Kilby** comes up with **the idea** of creating a monolithic device (**integrated circuit**) on a single piece of silicon.

Later (in 2000) Kilby receives Nobel price in physics



Jack Kilby completes building the first integrated circuit, containing five components on a piece of germanium half an inch long and thinner than a toot



1958

SAGE -- Semi-Automatic Ground Environment -- linked hundreds of radar stations in the United States and Canada in **the first large-scale computer communications network.**

1959

Fairchild Semiconductor files a patent application for the planar process for manufacturing transistors. The process makes commercial production of transistors possible and leads to Fairchild's introduction, in two years, of the first integrated circuit.

Texas Instruments **announces the discovery of the integrated circuit**.

At Fairchild Semiconductor, **Robert Noyce constructs an integrated circuit** with components connected by aluminum lines on a silicon-oxide surface layer on a plane of silicon.

Fairchild Semiconductor announces **their independent discovery** of the integrated circuit.

1960

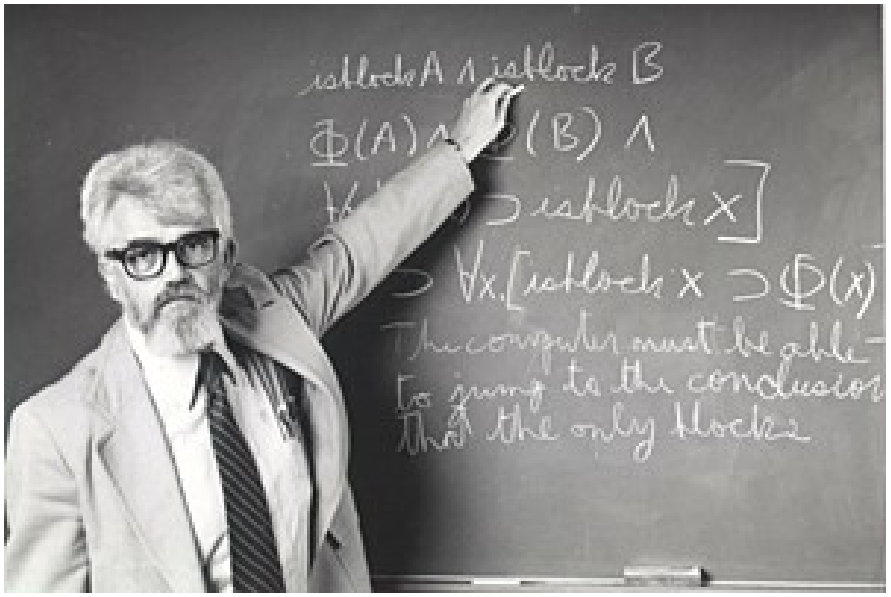
IBM develops the first **automatic mass-production facility** for transistors, in New York.

AT&T designed its Dataphone, **the first commercial modem**, specifically for converting digital computer data to analog signals for transmission across its long distance network

1960

A team drawn from several computer manufacturers and the Pentagon developed **COBOL**, Common Business Oriented Language. Project leader: Grace Hopper.

LISP made its debut as the first computer language designed for writing artificial intelligence programs. Inventor: John McCarthy.



1961

Fairchild Semiconductor releases **the first commercial integrated circuit**.

According to Datamation magazine, **IBM had an 81.2-percent share** of the computer market in 1961, the year in which it introduced the 1400 Series.

1962

Teletype ships its Model 33 keyboard and punched-tape terminal, used for input and output on many early microcomputers.

Ivan Sutherland creates a graphics system called **Sketchpad**.

1963

Douglas Engelbart receives a patent on the **mouse** pointing device for computers.

ASCII -- American Standard Code for Information Interchange -- permitted machines from different manufacturers to exchange data

Digital Equipment **sells its first minicomputer**, to Atomic Energy of Canada.

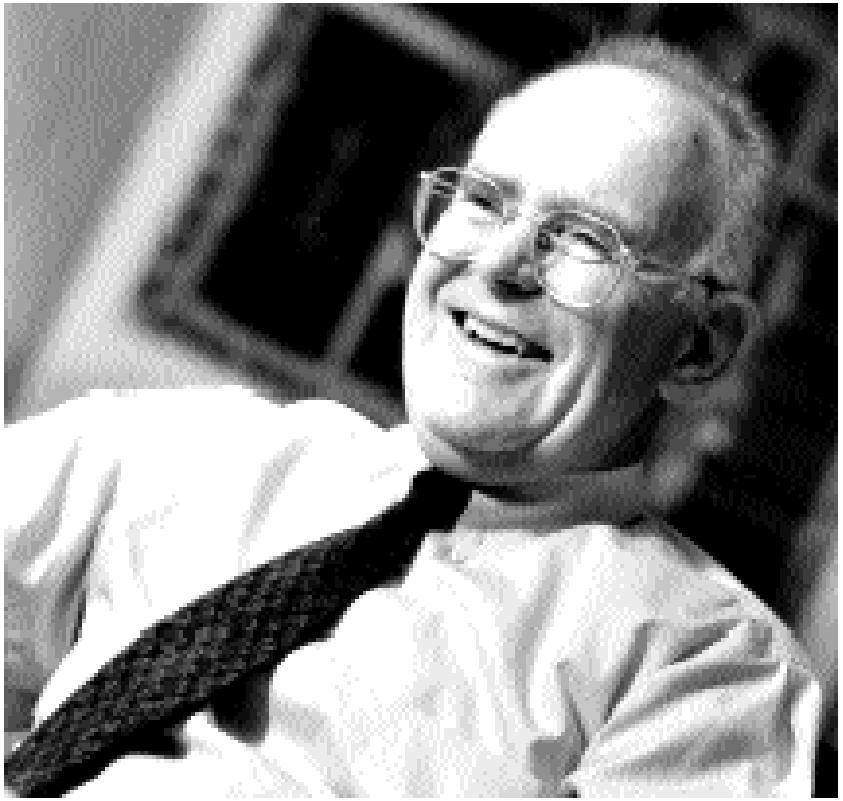
1964 ...

Ian Sharp and others found I.P. **Sharp Associates**, in Canada.

IBM announced **System/360**, a family of six mutually compatible computers and 40 peripherals that could work together

...1964

Gordon Moore suggests that integrated circuits would double in complexity every year. This later becomes known as **Moore's Law**.



Gordon E. Moore

1929 -

1950 B.S. in Chemistry

1954 Ph.D. from Cal Tech

1954-1957 *Shockley Semiconductor*

1957 Co-Founder of *Fairchild Semiconductors*

1965 Moore's Law

1968 Moore, Noyce and Grove left *Fairchild Semiconductors* and founded ***Intel Corp.***

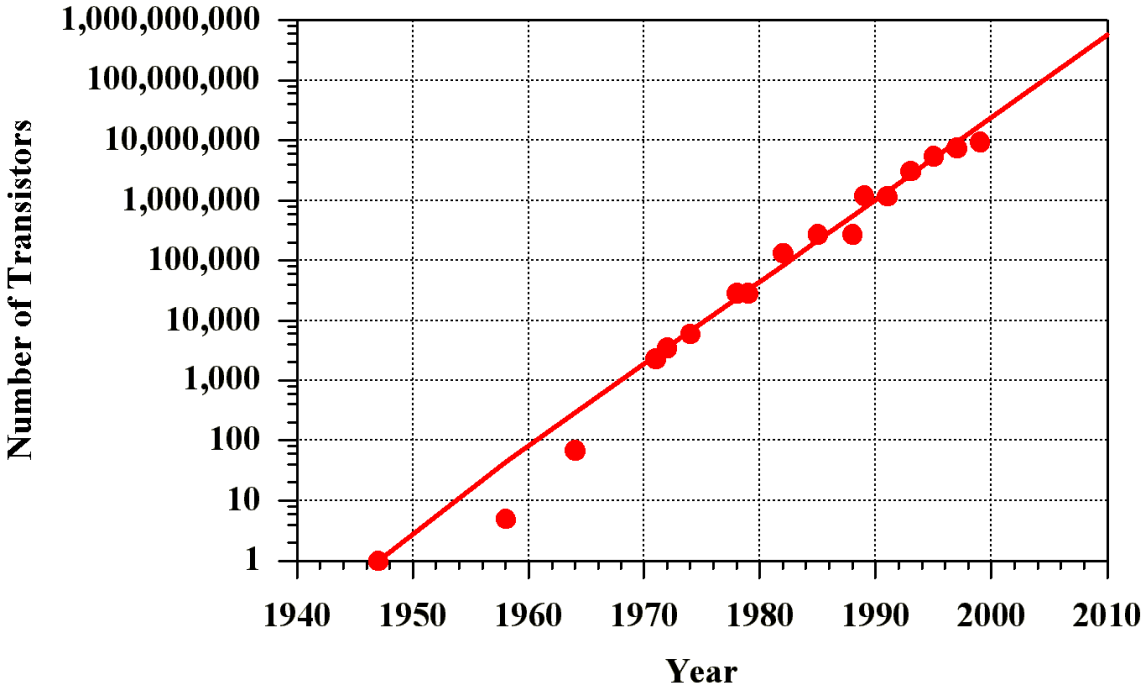
1968-1997 Intel's president President

Moore's law

Moore's Law (1965)

Circuits per chip

= 2 (year-1975) / 1.5



"Each new chip contains roughly twice as much capacity as its predecessor, and is released within 18-24 months of the previous chip."

...1964

CDC's 6600 supercomputer, designed by **Seymour Cray**, performed up to 3 million instructions per second -- a processing speed three times faster than that of its closest competitor, the IBM Stretch.

John Kemeny and Thomas Kurtz develop the **BASIC** programming language at Dartmouth College. BASIC is an acronym for Beginners All-purpose Symbolic Instruction Code.

Texas Instruments receives a **patent on the integrated circuit**.